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Effect of edible coatings on quality properties of cooked carp nuggets during frozen storage

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Abstract

This work was aimed to study the impact of some edible coatings; wheat flour, bread crumb and vegetar, on the quality of common carp fish nuggets stored at -18˚C for three months. Results showed that major constituents of cooked fish nuggets were fluctuated during frozen storage. While the values of pH, total volatile basic nitrogen (TVB-N) and trimethylamine nitrogen (TMA-N), thiobarbituric acid (TBA) and total plate count (TPC) were decreased up to the end of storage. Concerning color density, vegetar improved both a* (red-green) and b*(yellow-blue) value, while flour improved L* (lightness) of cooked carp nuggets. In conclusion, carp fish as low price fish could be exploited as ready to eat products. Variation in different treatments is due to chemical composition of taken part from dorsal muscles as well as ingredients of each edible part and frozen storage periods too.

Keywords: Carp fish, Nuggets, Edible coatings, Frozen storage.

Introduction

Increasing consumer's preference for ready-to-eat foods, efforts have been made to improve the quality and stability of minced meat, fish burger, fish finger, marinated products, etc. as result more work of women **(Kouse*et al.*, 2006 and Weber *et al.*, 2008).** Besides, there is great interest in edible coatings especially in sensitive foods such as seafood, due to their biocompatibility, biodegradability, broad application potential and use as carriers of functional ingredients to maintain the quality and prolong the shelf-life of foods as reviewed by **Kilincceker *et al.*, (2009); Song *et al.*, (2011**) and **Ruiz-Navajas *et al.*, (2013**). Although most pre-packaged foods found on the market are frozen however frozen fish products can undergo undesirable changes that induce protein denaturation and lipid oxidation continue to occur even at low temperatures, resulting in reduce stability and quality loss (**Yerlikaya *et al.*, 2005**; **Tokur *et al.*, 2006; Adegoke** and **Olapade, 2012**). On the other hand, Carps are one of the most widely cultured species due to its fast growth rate, easy cultivation however intramuscular bones are penetrated into tissues and have a bad smell (**Tokur*et al.*, 2006** and **Shabanpour and Jamshidi 2013)**. Therefore, this study was planned to investigate the impact of some edible coatings such as wheat flour, bread crumb and vegetar on quality criteria of common carp fish nuggets during frozen storage at -18ºC for 3 months.

Materials and methods

About 20 kg of common carp (*Cyprinus carpio* L.) were obtained from Benha fish market, Qalyubia Governorate, Egypt during October, 2014. They were transported immediately using ice box within one hour to Fish Processing and Technology Laboratory, El-kanater El-khairia Fish Research Station, National Institute of Oceanography and Fisheries, Egypt. The average weight (Mean ± SD) of common carp samples was 4.132±1.132kg. After that, they were washed, using tap water, beheaded, removed of scales, fins, skin, viscera and large bones, and then filleted, rewashed, then drained. The yield of flesh achieved by hand-filleting was 44.09%. Fish fillets were soaked in saturated brine solution (26% Sodium chloride) contained 0.02% acetic acid for 1-2 min at ambient temperature, washed with tap water and drained. Treated fillets were trimmed to obtain cubic shape for coated nuggets which were prepared from dorsal muscles. Fish nuggets manufactured as described by **Abdel Aziz (2013)**, fish nuggets, equal cubic pieces were immersed into batter solution contained 1.5% eggs, 4.5% chopped onion, 0.28% salt, 0.22% black pepper, 0.33% cumin, 0.22% thyme, 0.22% ginger, 0.22% cardamom, 0.22% cubeb, 2.31% bread crumb and 2.62% starch. All ingredients were purchased from local market. Finally, semi processed products of nuggets were breaded with flour, bread crumb and vegetar. Prepared fish nuggets were cooked using electrical fryer pan (Moulinex brand) in sun flower oil preheated at 170˚C for 5 min, cooled under room temperature, stored at -18ºC and analyzed for 3 months.

Analytical Methods

Chemical composition (moisture, crude protein (N×6.25), lipid, and ash content) and trimethylamine nitrogen (TMA-N) contents were determined according to **AOAC (2012).**The pH value was

measured as described by **Zaika *et al.*, (1976).**Total volatile basic nitrogen (TVB-N) content and thiobarbituic acid (TBA) value were determined as mentioned by **Pearson (1976)**. Total plate count (TPC) was examined according to **Oxoid (2006).** Color density**;** *L** (lightness), *a** (red-green) and *b** (yellow-blue) of fish nuggets was determined using a Hunter lab color flex EZ, USA. Sensory evaluation was assessed according to the procedure of **Fey and Regenstein (1982).** The obtained data (n=3 was statistically analyzed and expressed as mean ± SD using SPSS ver. 20.

Results and discussion:

Chemical composition:

Effect of edible coatings on chemical composition of cooked nuggets during frozen storage at -18ºC for three months is shown in **Table (1)**. It could be noticed that moisture content was 50.00% of cooked nuggets coated with wheat flour at zero time, increased to 52.29% after first month storage and decreased to 48.65% after second month storage, then increased to 51.29% after third month storage. In case of bread crumb, it was 50.01% at zero time, increased to 54.29%after first month storage and decreased to 50.82%after second month storage, then increased to 54.44% after third month storage. Concerning vegetar, it was 50.00% at zero time, increased to 53.31% after first month storage and decreased to 48.56% after second month storage, then increased to 51.94% after third month storage. These results are confirmed by **Zaitsev *et al.*, (1969)** and **Silva *et al.*, (2011**) who reported that the increment in the moisture content of cooked nuggets is directly related to the water retention in the product. While in case of decrease in water content, it may be attributed to cell damage caused by the ice crystals formed during freezing as reported by **Reddy *et al.*, (2012**).

Protein content (ww) of cooked nuggets coated with edible coatings during frozen storage is revealed in Table (1). Protein content was 17.34% in cooked nuggets coated with wheat flour at zero time, increased to 22.25% after first month storage and increased to 24.17% after the second month storage, then decreased to 23.02%after third month storage. In cooked nuggets with bread crumb, it was 18.97% at zero time, increased to 20.67% after first month storage and increased to 21.54% after second month storage, then decreased to 19.86% after third month storage. While in cooked nuggets with vegetar, it was 19.97% at zero time, increased to 22.33% after first month, then increased to 23.27% after the second month storage, then decreased to 22.28% at the end of storage period. The loss of protein content may be due to the denaturation of proteins during frozen storage and also due to the changes in the proportion of chemical composition and protein breakdown **(Rathod** and **Pagarkar, 2013** and **Gupta *et al.*, 2015)**. While the increase in the protein content may be attributed to decrease in moisture (**Talab, 2014**).

From the same **Table (1)**, it was found that lipid content was 13.10% in cooked nuggets coated with wheat flour after zero time, decreased to 11.76% after first month storage and increased to 12.37% after second month storage, then decreased to 9.33% after the end of storage period. In cooked nuggets with bread crumb, it was 13.25% after zero time, decreased to 11.66% after first month**,** and increased to 13.66% after second month, then decreased to 12.03% after third month. While in cooked nuggets with vegetar, it was 11.46% at zero time, decreased to 10.60% after first month, and increased to 13.92%after second month, then decreased to 12.65% at the end of storage period. These results are in accordance with those findings by **Saguy** and **Dana (2003)** and **Talab (2014**) who reported that an increase and decrease in lipid content may be attributed to change in moisture.

Also, in **Table (1)** shows ash content, it was 3.21% of cooked nuggets coated with wheat flour at zero time, decreased to 1.89% after first month storage and increased to 2.41% after second month storage, then decreased to 1.13% at the end of storage period. In cooked nuggets with bread crumb, it was 2.40% at zero time, decreased to 1.58% after first month**,** and increased to 1.70% after second month, then decreased to 1.36% after third month. While in cooked nuggets with vegetar, it was 2.64% at zero time, decreased to 1.11% after first month, and increased to 1.4% after second month, then decreased to 1.10% at the end of storage period. The loss in ash during storage is due to remove of minerals content with the drip water and increase in moisture content while increase in ash content may be attributed to decrease in moisture as reported by **Zaitsev *et al.*, (1969)** and **Kilinc *et al.*, (2008**), (**Ordonez-Ramos et *al.*, 2012**).

Quality criteria of cooked nuggets:

pH value:

Table (2) shows the changes in pH values of cooked nuggets coated with edible coatings during the frozen storage. It was 6.29 of cooked nuggets coated with wheat flour at zero time, reduced to 6.03 after first month storage and increased to 5.74after second month storage, then reduced to 5.30 at the end of storage period. In cooked nuggets with bread crumb, it was 6.03 at zero time, decreased to 5.75 after first month**,** and increased to5.71after second month, then decreased to5.14after third month. While in cooked nuggets with vegetar, it was 6.14 at zero time, decreased to 5.89 after first month, and increased to 5.64 after second month, then reduced to 5.28 at the end of storage period. This data confirms a decline in pH value during storage was attributed to formation of lactic acid from

glycogen as a result of autolysis (**Aycicek *et al*., 2004** and **Kilinc *et al*., 2008**).

TVB-N content:

Table (2) shows the TVB content in cooked nuggets coated with some edible coatings during the frozen storage. It was 26.6 of cooked nuggets coated with wheat flour at zero time, reduced to 22.4, 21.2 and 17.6 mg\100g after first, second and third month storage, respectively. In cooked nuggets with bread crumb, it was 28.7at zero time, decreased to 22.4, 18.2 and 16.6mg\100g after first, second and third month storage, respectively. While in cooked nuggets with vegetar, it was 26.6 at zero time, decreased to 25.9, 22.4and18.2mg\100g after first, second and third month storage, respectively. TVB content decreased till the third month in all cooked nuggets. The declining of TVB-N values might be the removal of free amino acids, sarcoplasmic protein, or N-containing compounds of non-protein nature during washing and also, absence of microbial activity during frozen storage (**Kaba 2006** and **Asgharzadeh *et al*., 2010**) and also, decreasing of TVB content may be result of hypothesis that mentioned for reduction of pH value (**Talab, 2014**).

TMA-N content

Table (2) shows the levels of TMA-N in cooked coated nuggets with some edible coatings during the frozen storage. It was 0.89mg\100g of cooked nuggets coated with wheat flour at zero time, reduced to 0.65, 0.18and 0.09mg\100g after first, second and third month storage, respectively. In cooked nuggets with bread crumb, it was 0.79at zero time, decreased to 0.37, 0.18and 0.09 mg\100g after first, second and third month storage, respectively. While in cooked nuggets with vegetar, it was 0.84at zero time, decreased to 0.32, 0.18 and 0.09mg\100g after first, second and third month storage, respectively. TMA-N content showed a gradual decrease up to the third month in all cooked nuggets. A decrease in TMA value may be due to the effect of freezing **(Izci *et al*., 2011** and **Baygar *et al*., 2013)**.

TBA value

As shown in **Table (2)**, It was 0.43mg MA\kg of cooked nuggets coated with wheat flour at zero time, reduced to 0.31, 0.40and 0.34mg\100g after first, second and third month storage, respectively. In cooked nuggets with bread crumb, it was 0.50mg MA\kg at zero time, decreased to 0.40, 0.54and 0.41 mg MA\kg after first, second and third month storage, respectively. While in cooked nuggets with vegetar, it was 0.23 mg MA\kg at zero time, decreased to 0.20, 0.50 and 0.17 mg MA\kg after first, second and third month storage, respectively. Levels of TBA decreased after the first month in all cooked coated nuggets, increased after the second month storage, but decreased after the third month of storage. The decrease in TBA was attributed to the retardation of lipid oxidation by products of lipid hydrolysis and interaction of malonaldehyde/ aldehyde with proteins and also, it was due to the added spices which could have contributed to the reduction of lipid oxidation because of their antioxidant properties and there by reduced the TBA value (**Ninan*et al*., 2010**). While the increase in the value of TBA, due to the increase of lipid content than the lipid oxidations resulting from action of lipolytic enzymes (lipases and phospholipases) that fish phospholipids undergo degradation to produce hydroperoxides, Aldehydes and ketones which are responsible for the development of oxidative rancidity **(Raharjo *et al*., 1992).**

TPC

As shown in **Table (3)**, it was 2.0×10^3cfu\g of cooked nuggets coated with wheat flour at zero time, reduced to 4.8×10^2, $0.4\times10^2$and 0.2×10^2cfu\g after first, second and third month storage, respectively. In cooked nuggets with bread crumb, it was4.5×10^2 cfu\g at zero time, decreased to 6.2×10^3, 0.8×10^2 and 0.6×10^2cfu\g after first, second and third month storage, respectively. While in cooked nuggets with vegetar, it was2.6×10^3cfu\gat zero time, decreased to 7.1×10^2, $0.7\times10^2$and 0.4×10^2cfu\g after first, second and third month storage, respectively. TPC reduced in numbers of microorganisms with increase storage periods. This decrease in microbial load may be due to the mechanical damage of bacterial cell caused by crystals during freezing and the powerful antimicrobial properties of food additives **(Liston, 1980 and Block, 1992).**

Color density

The data present in **Table (4)** shows that L* value was 49.61 of cooked nuggets with wheat flour at zero time, then decreased to 43.94 after first month, and increased to 47.68 after second month, then decreased to 46.11 at the end of storage period. While a* value was 0.69 at zero time, increased to 4.94 after first month, and decreased to 4.49 after second month, then increased to 4.73 at the end of storage period. While b* value was 13.53 at zero time, increased to 13.93 after first month, then decreased to 13.31 after second month, then increased to 13.47 at the end of storage period.

While in nuggets with bread crumb, L* value was 41.23 at zero time, increased up to 55.08 after second month, then decreased to 50.27 at the end of storage period. While a* value was 3.43 at zero time, increased to 5.65 after first month, and decreased to 4.17 after second month, then increased to 4.66 at the end of storage period. While b* value was 12.15 at zero time, and increased to 13.01 after first month, and decreased to 11.14 after second month, then increased to 12.27 at the end of storage period.

While in nuggets with vegetar, L* value was 49.43 at zero time, decreased up to 37.85 after second month, then increased to 38.43 at the end of storage period. While a* value was 1.86 at zero time, increased up to 6.37 at the end of storage period. While b* value was 14.32 at zero time, increased to 14.57 after first month, decreased to 13.45 after second month, then increased to 16.24 at the end of storage period. These results are in accordance with those reported by **Kilinc *et al*., (2008) and Simsek** and **Kilic (2013).** Finally, vegetar improved both a* and b* while flour improved L* of cooked carp nuggets.

Sensory evaluation

Effect edible coatings on sensory tests of cooked nuggets during frozen storage are presented in **Table (5).**High scores of all sensory tests (odor, taste, texture and overall acceptability) are given for cooked nuggets with bread crumb, followed by flour and vegetar. Concerning effect of frozen storage, bread crumb improved the odour, flour improved the taste while vegetar improved both texture and overall acceptability of nuggets. The scores of all sensory tests decreased at the end of storage of cooked nuggets. The lower of sensory scores was could be due to lipid oxidation and rate of rancidity as showed **Connel (1995**).

In conclusion, carp fish as low price fish could be exploited as ready to eat products. Concerning color density, vegetar improved both a* and b* while flour improved L* of cooked carp nuggets. Variation in different treatments is due to chemical composition of taken part from dorsal muscles as well as ingredients of each edible part and frozen storage periods.

Table 1. Effect edible coatings on proximate analysis of cooked nuggets coated during frozen storage.

Frozen Storage Period (months)	Cooked carp nuggets coated with;											
	Wheat flour				Bread crumb				Vegetar			
	Moisture	Protein	Lipid	Ash	Moisture	Protein	Lipid	Ash	Moisture	Protein	Lipid	Ash
0	50.00±3.81	17.34±2.11	13.10±0.12	3.21±0.01	50.01±0.03	18.97±0.49	13.25±2.73	2.40±0.13	50.00±0.09	19.97±0.47	11.46±0.27	2.64±0.04
1	52.29±0.48	22.25±0.58	11.76±0.89	1.89±0.35	54.29±0.68	20.67±0.50	11.66±0.80	1.58±0.80	53.31±0.67	22.33±0.14	10.60±0.80	1.11±0.52
2	48.65±0.84	24.17±0.79	12.37±0.36	2.41±0.71	50.82±0.97	21.54±0.87	13.66±0.56	1.70±0.90	48.56±0.34	23.27±0.30	13.92±0.95	1.4±0.85
3	51.29±1.07	23.02±0.32	9.33±0.60	1.13±0.54	54.44±0.70	19.86±0.87	12.03±0.38	1.36±0.58	51.94±0.49	22.28±0.64	12.65±0.34	1.10±0.90

Table 2. Effect edible coatings on quality criteria of cooked nuggets coated during frozen storage.

Frozen Storage Period (months)	Cooked carp nuggets coated with;											
	Wheat flour				Bread crumb				Vegetar			
	pH value	TVB-N mg /100g	TMA-N mg /100g	TBA value mg MA/kg	pH value	TVB-N mg /100g	TMA-N mg /100g	TBA value mg MA/kg	pH value	TVB-N mg /100g	TMA-N mg /100g	TBA value mg MA/kg
0	6.29±0.0	26.6±8.40	0.89±0.01	0.43±0.02	6.03±0.0	28.7±0.00	0.79±0.00	0.50±0.08	6.14±0.1	26.6±4.9	0.84±0.0	0.23±0.04
1	1	22.4±0.20	0.65±0.04	0.31±0.05	7	22.4±0.60	0.37±0.01	0.4±0.05	3	0	1	0.20±0.05
2	6.03±0.1	21.2±0.60	0.18±0.07	0.40±0.20	5.75±0.8	18.2±0.80	0.18±0.09	0.54±0.06	5.89±0.9	25.9±1.1	0.32±0.0	0.50±0.30
3	4	17.6±0.20	0.09±0.09	0.34±0.90	8	16.6±1.15	0.09±0.09	0.41±0.05	5	9	6	0.17±0.05
	5.74±0.2				5.71±0.8				5.64±0.7	22.4±0.2	0.18±0.0	
	0				6				8	0	7	
	5.30±0.3				5.14±0.5				5.28±0.4	18.2±0.1	0.09±0.0	
	9				0					3	4	

Table 3. Effect edible coatings on total plate count (TPC) of cooked nuggets coated during frozen storage.

Frozen storage period (months)	Cooked carp nuggets coated with;		
	Wheat flour	Bread crumb	Vegetar
0	2.0×10^3	4.5×10^3	2.6×10^3
1	4.8×10^2	6.2×10^2	7.1×10^2
2	0.4×10^2	0.8×10^2	0.7×10^2
3	0.2×10^2	0.6×10^2	0.4×10^2

Table 4. Effect edible coatings on color property of cooked nuggets coated during frozen storage.

Frozen storage period (months)	Color of cooked nuggets coated with;								
	Wheat flour			Bread crumb			Vegetar		
	L*(Lightness)	a*(Red-green)	B*(Yellow-blue)	L*(Lightness)	a*(Red-green)	B*(Yellow-blue)	L*(Lightness)	a*(Red-green)	B*(Yellow-blue)
0	49.61	0.69	13.53	41.23	3.43	12.15	49.43	1.86	14.32
1	43.94	4.94	13.93	47.54	5.65	13.01	44.54	5.14	14.57
2	47.68	4.49	13.31	55.08	4.17	11.14	37.85	6.20	13.45
3	46.11	4.73	13.47	50.27	4.66	12.27	38.43	6.37	16.24

Table 5. Effect edible coatings on sensory tests of cooked nuggets coated during frozen storage.

Frozen storage period (months)	Cooked carp nuggets coated with;											
	Wheat flour				Bread crumb				Vegetar			
	Odor	Taste	Texture	Overall acceptability	Odor	Taste	Texture	Overall acceptability	Odor	Taste	Texture	Overall acceptability
0	7.57±0.3	7.42±0.52	7.85±0.2	7.61±0.50	8.00±0.6	8.28±0.57	9.00±0.56	8.42±0.56	7.28±0.3	7.85±0.4	8.00±0.4	7.60±0.59
1	6	7.55±.01	6	7.08±0.48	0	7.60±0.60	8.19±0.37	7.00±0.48	0	2	5	7.12±0.04
2	7.32±0.8	7.33±0.36	7.18±0.4	6.63±0.42	7.62±0.4	6.28±0.33	6.00±0.49	6.52±0.50	7.29±0.3	7.14±0.4	6.93±0.6	6.89±0.25
3	0	7.16±0.58	0	6.11±0.63	8	5.59±0.20	5.61±0.37	5.98±0.42	7	0	3	6.48±0.63
	6.15±0.3		6.43±0.7		7.29±0.6				6.81±0.4	6.94±0.4	6.94±0.4	
	0		0		0				2	2	4	
	5.29±0.6		5.89±0.6		6.76±0.4				6.33±0.4	6.52±0.6	6.59±0.5	
	0		6		0				8	0	8	

1-4 rejected; 5-6 accepted; 6-7: good; 7-8: very good; 9-10: excellent.

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تأثير مواد التغطية الغذائية على خصائص جودة ناجتس المبروك المطهى خلال التخزين بالتجميد

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يهدف هذ البحث إلى دراسة تأثير بعض مواد التغطية الغذائية (دقيق الذرة، البقسماط، الفيجتار) على جودة ناجتس سمك المبروك العادى والمخزن على درجة حرارة −18°م لمدة ثلاثة أشهر. وأظهرت النتائج أن التركيب الكيماوى لناجتس السمك المطهى كانت غير ثابت أثناء التخزين بالتجميد. بينما حدث إنخفاض بنهاية فترة التخزين لكلا من قيم رقم الحموضة، النيتروجين الكلى المتطاير، ثلاثى ميثيل أمين، ورقم الثيوباربتيوريك والعدد الكلى للبكتريا. وبالإشارة إلى كثافة الألوان فإن إضافة الفيجتار أدت إلى تحسن قيم كلا من a* and b* بينما أدت إضافة الدقيق إلى تحسن قيم L* فى ناجتس المبروك المطهى. أثبتت النتائج أن أسماك المبروك منخفضة الثمن ويمكن أن تكون مصدرالمنتجات سمكية جاهزة للأكل. والإختلاف فى المعاملات المختلفة يرجع إلى إختلاف التركيب الكيميائى للجزء المأخوذ من العضلات وكذلك بسبب إختلاف المكونات لكل جزء غذائى وكذلك أثبتت النتائج أن لفترة التخزين بالتجميد تأثير على التركيب الكيميائى وخصائص جودة ناجتس المبروك.